

Preliminary findings on morphological differences between five subspecies of Royal Flycatcher *Onychorhynchus coronatus*.

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Introduction

The Royal Flycatcher *Onychorhynchus coronatus* [Müller, 1776] is widely distributed from Mexico through central America and into South America where it occurs in the pacific lowlands of Ecuador, the Amazon basin and Atlantic coastal forests of south-eastern Brazil. Five subspecies are recognised: *mexicanus* distributed from Mexico to Honduras; *fraterculus* from Honduras to northern Colombia; nominate *coronatus* in much of the low lying Amazon basin (here including the form *castehau* from the Peruvian Amazon [Ridgely & Tudor 1992]); and finally, two isolated populations *occidentalis* from western Ecuador and *swainsonii* from south-east Brazil.

It has been suggested in recent times that several of these subspecies deserve species recognition. *Mexicanus* has been regarded as a separate species, the Mexican Royal Flycatcher (Peterson & Chalif 1973) as has *Swainsonii*, the Atlantic Royal Flycatcher (Collar *et al.* 1992) and *Occidentalis*, the Pacific Royal Flycatcher (Collar *et al.* 1994, Williams *et al.* 1996, Ridgely *et al.* 1998). The latter two forms found on the extreme limits of both the eastern (Atlantic Royal Flycatcher) and western ranges (Pacific Royal Flycatcher) are both isolated and threatened by extinction (Collar *et al.* 1992, Collar *et al.* 1994). Sibley & Munroe (1991,1993) list four distinct forms of the species: *coronatus*, *mexicanus*, *occidentalis* and *swainsonii*. This note presents morphological data from museum skins of the five different subspecies and reviews the current status of this group. The aim of this note is to present findings using small sample sizes in order to encourage further ecological and museum work into this group. It does not intend to provide categorical evidence that Royal Flycatcher be split into several new species.

Methods

Museum skins

Ninety-two skins at the British Museum of Natural History, Tring, England were used in these analyses. Six structural measurements (to the nearest 0.1mm) from each specimen were taken using a wing rule and callipers. They were as follows:

1. Overall body length - from tip of bill to end of tail.
2. Head and bill - from the furthest point at the back of the skull to the tip of the bill.
3. Bill width - the width of the bill at the widest point.
4. Wing length - the unflattened wing chord of the right wing.
5. Bill length – from the tip of the bill to the beginning of the feathering.
6. Tail length – between central retrices to when the rule is pressed against the abdomen.

In addition the plumage colouration of the underparts and upperparts were scored using the following system: (1) Sandy (2) Sandy/rufous (3) Rufous/buff (4) Ruddy brown (5) Plain brown (6) Dark brown. All plumage scores were taken before reading the label on each specimen to try and eliminate sampling bias.

Analysis

Principal Components Analysis was used as a tool for preliminary examination of the morphological data. General Linear Models were used to investigate specific differences between separate morphological and plumage characters of the groups. 95% confidence limits were calculated to compare differences between groups. All statistical tests were carried out using Minitab 10.2.

Results

The primary and secondary axis of the PCA together accounted for 73% of the original variation. Figure 1 shows the primary axis plotted against the secondary axis. The first principal component axis (PC1) separated *coronatus* and *swainsonii* from *mexicanus* and *fraterculus* (Figure 1). Character loadings (Table 1) suggested that birds from *coronatus* and *swainsonii* groups (with higher PC1 scores) tended to have smaller body lengths and head and bill measurements than birds with lower PC1 scores (i.e. *mexicanus* and *fraterculus*). The second principal components axis (PC2) provided poor resolution between subspecies but one subspecies, *swainsonii*, perhaps separated from the others on this axis. This suggests that birds with higher PC2 scores tended to have longer bills than those with lower scores (i.e. birds belonging to the *swainsonii* group).

Table 1. Character loadings on principal component axes (PC1 and PC2) for a Principal Component Analysis of six morphological measurements taken from Royal Flycatchers.

Variable	Principal Component Axis 1	Principal Component Axis 2
Body length	-0.45	-0.14
Head and bill	-0.45	+0.22
Bill width	-0.37	+0.24
Wing length	-0.41	-0.36
Bill length	-0.35	+0.68
Tail length	-0.41	-0.53
Eigenvalue	3.52	0.86
% variation explained	58.6	14.4

Figure 1. Plot of first (PC1) and second (PC2) principal components for a Principal Components Analysis of six morphometric measurements from five subspecies of Royal Flycatcher.

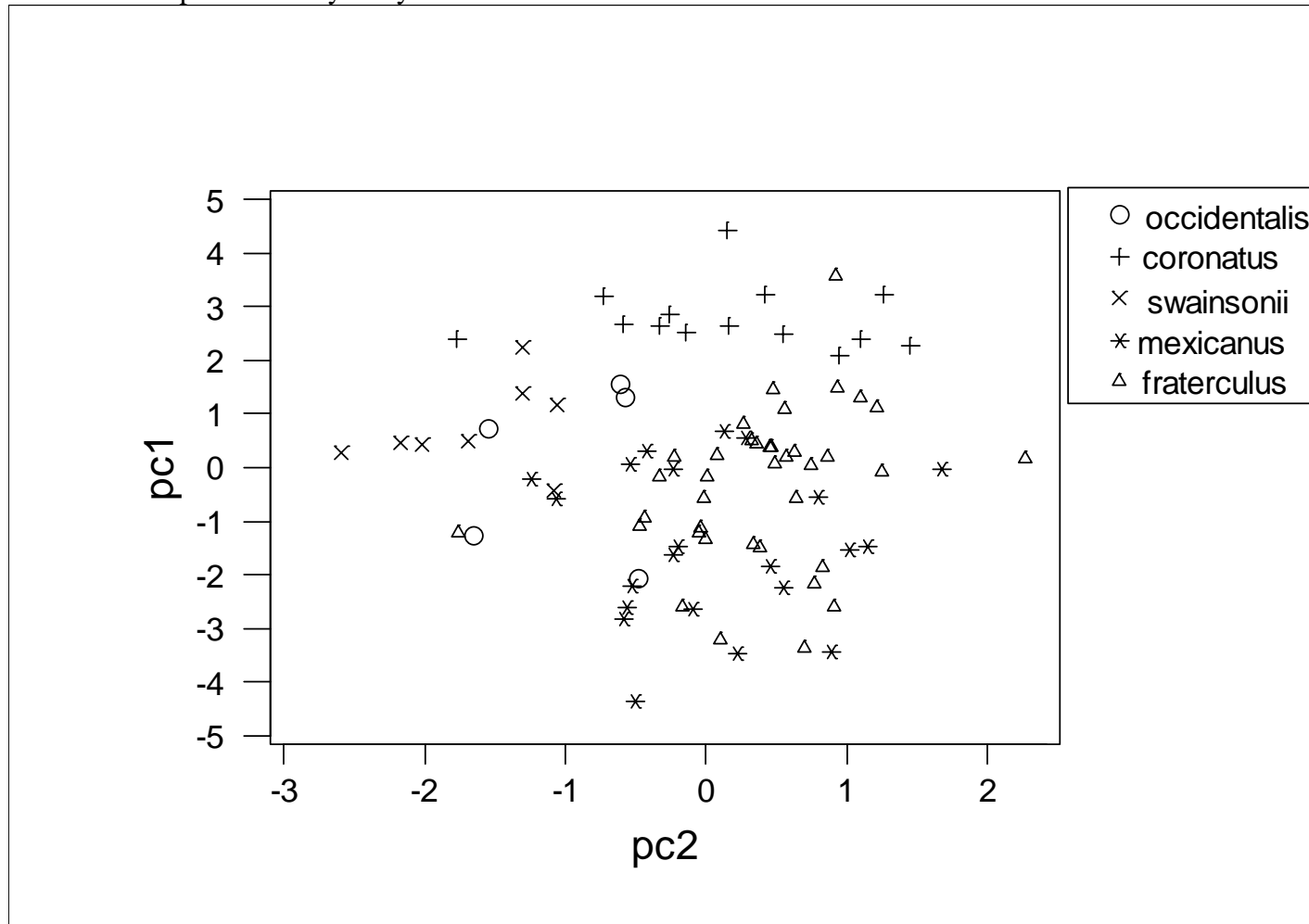


Table 2. Biometric data (mean \pm 1 S.D.) for the five subspecies. General Linear Models were used to test for differences between groups and, in all cases, Kruskal-Wallis tests yielded results significant to $p < 0.001$. Sample sizes are in parentheses.

	<i>Coronatus</i> (16)	<i>Fraterculus</i> (38)	<i>Occidentalis</i> (5)	<i>Mexicanus</i> (23)	<i>Swainsonii</i> (8)	Significant Differences between groups. Note:*** $p < 0.001$
MORPHOLOGY						
Body size (mm)	143.12 \pm 5.41	160.89 \pm 12.8	163.0 \pm 14.85	165.87 \pm 10.43	153.88 \pm 5.30	***
Head and bill (mm)	40.44 \pm 2.01	43.71 \pm 2.00	43.90 \pm 3.02	45.71 \pm 2.09	41.79 \pm 3.11	***
Bill width (mm)	8.48 \pm 0.51	9.31 \pm 0.46	8.76 \pm 0.29	9.50 \pm 0.59	9.39 \pm 0.16	***
Wing length (mm)	75.19 \pm 3.47	81.97 \pm 4.18	78.8 \pm 2.17	84.57 \pm 4.27	83.25 \pm 2.92	***
Bill length (mm)	17.61 \pm 1.31	21.34 \pm 1.41	18.4 \pm 2.03	21.05 \pm 1.82	14.79 \pm 0.51	***
Tail length (mm)	60.57 \pm 4.11	68.00 \pm 4.83	75.00 \pm 6.29	71.05 \pm 4.66	70.25 \pm 3.99	***
COLOURATION						
Underpart colouration	1.59 \pm 0.27	1.03 \pm 0.16	0.70 \pm 0.27	1.07 \pm 0.23	1.56 \pm 0.42	***
Upperpart colouration	3.97 \pm 0.13	3.70 \pm 0.27	2.10 \pm 0.22	3.65 \pm 0.32	2.88 \pm 0.23	***

Significant differences between the five groups were found when each morphological characteristic was compared separately (Table 2). *Coronatus* individuals had smaller measures for five morphological characteristics (the exception being bill length). The *fraterculus* and *mexicanus* groups tended to be very similar in all measurements with 95% confidence limits overlapping for all but head and bill (*mexicanus* being bigger). These two groups had larger bill width, bill lengths and wings than *occidentalis*. They also had larger bodies and longer head and bill measurements than birds of the *swainsonii* subspecies.

The underpart colouration scores were significantly darker (95% confidence limits) in *coronatus* and *swainsonii* specimens than in *fraterculus* and *mexicanus*. *Occidentalis* birds scored significantly lighter than any of the others. There were no significant differences for the scores given to the upperparts of *fraterculus*, *coronatus* and *mexicanus*, but all three were scored significantly darker than *swainsonii*, which was in turn scored significantly darker than *occidentalis*.

Discussion

The morphological and plumage differences described here provide the first analysis of its type of the five subspecies of Royal Flycatcher. PC 1, in a Principal Components Analysis of morphometric measurements, approximates to an axis of 'body size' and PC2 to a 'shape' axis (Rising & Somers 1989, Reynolds 1996). In this study PC1 highlighted the smaller size of *coronatus* and *swainsonii* from *mexicanus* and *fraterculus* and PC2 the shorter bill of *swainsonii*. The general linear models supported the results from the Principal Components Analysis. *Swainsonii* and *occidentalis* were consistently lighter on the upperparts, and *occidentalis* on the underparts as well, than the other subspecies, even given the small samples used in this study. These differences are intriguing but on their own we do not consider them enough to draw any firm conclusions about the taxonomic status of the complex.

The behaviour and vocalisations of the subspecies have been noted as being similar across subspecies (Ridgely & Tudor 1992). All five subspecies are often found alone or in pairs, in mature secondary forest and borders (Ridgely & Tudor 1992, Collar *et al.* 1992). The nesting preferences for overhanging vegetation, often near water are similar for *occidentalis*, *coronatus* and *mexicanus* (Whittingham 1994, Berg 1995, pers obs). Royal Flycatchers do not often vocalise (Ridgely & Tudor 1992). Taped vocalisations for *mexicanus* and *coronatus* exist, but I could find no recordings for the other subspecies in an albeit fairly limited search.

An assumption with this data is that the specimens were labelled correctly by the museum. The error caused by this is unknown in this study as the museum labels were used unquestioningly in this study. A way to improve the analysis would be to incorporate the origin of each specimen into the analysis to investigate further patterns within each subspecies. This would also enable the source of outliers from each subspecies to be investigated (for example, was the outlier from *fraterculus* that fell within the range of *coronatus* within the ordination in Figure 1 a result of incorrect labelling or was it located very close to *coronatus* populations).

Considering the potential threats to *swainsonii* and *occidentalis*, it seems a priority that further research be undertaken to clarify the taxonomic position of the Royal Flycatcher complex. Further analyses of other museum specimens are recommended to reinforce our findings. We intend to widen this study by collecting more information from other museum specimens and including geographical location within the analysis. Furthermore, birders visiting South America could help by collecting recordings of vocalisations and ecological information on any Royal Flycatchers they may encounter.

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